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Fast multipole modeling of land mines in the presence of naturally occurring clutter

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The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.

12 a. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

12 b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This project has involved both numerical simulation of electromagnetic scattering for ultra-widenband synthetic aperture radar (SAR) for foliage and ground penetrating radar (FOPEN and GPEN, respectively). We have developed a fast multipole method (FMM) model for electromagnetic scattering from electrically large conducting targets in the presence of a half space, with application to scattering from surface/subsurface unexploded ordnance (UXO), as well as for scattering from surface vehicles, such as tanks. The FMM simulator is significantly faster than conventional method-of-moments (MoM) solvers. allowing solution of problems that were heretofore intractable. The code has been delivered to the Army Research Laboratory (ARL), and successfully compared with data measured by ARL.

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I. List of Manuscripts Submitted/Published under ARO Support

N. Geng, A. Sullivan and L. Carin, "Multilevel fast-multipole algorithm for scattering from conducting targets above or embedded in a lossy half space," IEEE Trans. Geoscience and Remote Sensing, Vol. 38 Issue: 4 Part: 1 , July 2000

N. Geng, A. Sullivan and L. Carin, "Fast multipole method analysis of scattering from a three-dimensional target in a half-space environment," submitted to the *IEEE Trans. Antennas Propagation*

J. He, A. Sullivan and L. Carin, "Multi-level fast multipole algorithm for general dielectric targets in the presence of a lossy half space," submitted to *Radio Science*

II. Scientific Personnel

Faculty: Lawrence Carin (PI)
Students: Jiangqi He
Post-doc: Traian Dogaru

III. Invention Reports

None

IV. Scientific Progress and Accomplishments

Over the last year of funding significant progress has been made on both signal processing and electromagnetic modeling. Considering first the modeling, we have developed a fast multipole method (FMM) simulator for electrically large targets embedded in a half-space region (i.e., for targets in the vicinity of soil). The model is applicable to very general targets, including buried or surface unexploded ordnance (UXO), vehicles and weapons. The model is also applicable for simulating the scattered fields from fiducial targets (trihedrals) placed above soil, these models playing a critical role in the calibration of foliage penetrating (FOPEN) radar systems, such as the ARL BoomSAR. In the future we will apply the FMM model for calibration of the BoomSAR, with this playing a critical role in the development of automatic target recognition algorithms for FOPEN systems.

V. Technology Transfer

The research reported here has been undertaken in close collaboration with the Army Research Laboratory (ARL), Adelphi, MD. The FMM modeling algorithms have been transition to ARL, and are being used routinely by ARL personnel. The same is true of the aforementioned signal processing algorithms.